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(54) **A METHOD AND APPARATUS FOR EXTRUSION OF EXPANDING WATER CONTAINING
PRODUCTS SUCH AS FOODSTUFF PARTICLES OR FEEDING STUFF PELLETS**

VERFAHREN SOWIE VORRICHTUNG ZUM EXTRUDIEREN VON EXPANDIERENDEN
WASSERHALTIGEN PRODUKTEN WIE LEBENSMITTELTEILCHEN ODER
FUTTERMITTELPELLETS

PROCEDE ET APPAREIL PERMETTANT L'EXTRUSION DE PRODUITS EN EXPANSION
CONTENANT L'EAU, NOTAMMENT DES PARTICULES DE DENREES ALIMENTAIRES OU DES
ALIMENTS GRANULES POUR ANIMAUX

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(56) References cited:
US-A- 4 031 267 US-A- 4 039 168

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Description

[0001] This invention relates to a method of product extrusion as specified in the introductory clause of claim 1.

[0002] In connection with the manufacture of extruded products it is essential that the physical dimensions of the extruded product are held constant at the desired dimensions.

[0003] This applies in the production of "solid" unexpanded products where it is desired to avoid expansion, and especially in the production of expanded products where the dimensions of the product are greater than the nozzle aperture(s), where it is aimed to achieve a specific dimension increase in relation to the nozzle dimension.

[0004] The problem presents itself mostly in the manufacture of expanded products where the expansion is normally aimed at in order to ensure specific characteristics, such as viscosity (fish-foods), sinking characteristics (specifically slow sinking speed of fish-foods), liquid absorption characteristics (fish-foods, pet-food, foodstuffs), constant low specific density (pet-food, snacks, breakfast products), constant crispness (fish-foods, pet-food, foodstuffs), constant physical shape (all products).

[0005] The ensuring of the above-mentioned constancy/controllability of the expansion gives rise to great problems with all extrusion systems. The degree of expansion of the extruded product in the extrusion plant depends on conditions such as:

Composition of raw materials.

Characteristic/quality of raw materials.

Extrusion process parameters:

* Dosing of the individual ingredients:

Flour mixing.

Liquids.

Steam.

* Cooling/heating of worms/linings.

* Speed of rotation of worm conveyor.

Configuration of the extruder's worm conveyor.

Configuration of the extruder nozzle.

Wear state of the process parts.

[0006] Especially the variations in the raw material and the wear state of the extruder's worm conveyor and linings give rise to variations in production which are difficult to predict.

[0007] Depending on the conditions which give rise to the product variations, it can be particularly difficult to ensure (via automatic process control and regulation, or manually), that the finished products correspond to the product specifications with reasonable tolerances.

[0008] During the extrusion process, products such as those described above containing starchy raw materials will, as a consequence of a process temperature of 100-200°C, a moistness of 10-35% H₂O, and a pressure of 2-80 bar in the extruder worm, typically gelatinise and convert to a plastic/elastic liquid-like form.

[0009] Such a process is described in US-A-4 031 267.

[0010] In its passage through the extruder's nozzle arrangement, the product will move from process pressure (2-80 bar) to atmospheric pressure, at which the cutting-off of the product in the desired length normally takes place. The fall in pressure across the nozzle plate and the energy content of the product will result in a momentary evaporation of a part of the product's water content in the opening of the extruder nozzles. The evaporation of the water forms steam pockets in the plastic/elastic mass, whereby the product expands. The fall in temperature brought about by the momentary evaporation results in a hardening of the product into a permanently firm and physical shape.

[0011] The expansion of the product normally stops, when the steam pressure in the steam pockets achieves a balance in relation to the elasticity of the mass,

and/or further development of steam stops as a consequence of the consumption of energy involved in the evaporation resulting in a drop in temperature to a temperature corresponding to the boiling point of the mass,

and/or when all of the walls in the steam pockets burst as a consequence of the internal steam pressure, and the pressure in the pockets is hereby normalised, whereby the driving force for further expansion disappears.

The invention

[0012] It is characteristic for all known extrusion systems for the production of feeding stuffs, foodstuffs or the like that the nozzle and cutting-off system of the extruding process operate under constant pressure - normally atmospheric pressure or possibly slight underpressure - created by associated aspiration systems or pneumatic transport systems.

[0013] To overcome or minimize the expansion control problems specified above, it has been found by the present invention that the extrusion with advantage can be effected into a pressure chamber at the outlet side of the nozzle plate, in which the product is shaped, cut-off and stabilised to a permanent form (expansion degree) before being discharged to atmospheric pressure. By regulation of the working pressure of the pressure chamber, it is possible to regulate the boiling point for the mass in the mouth of the nozzle arrangement, whereby the development of steam brought about by the extrusion can be controlled. This provides a corresponding possibility of controlling the driving force which

brings about the expansion of the product.

[0014] In accordance with the invention, the new method will be able to be used for optimisation of the expansion degree and capillary structure in products from all known types of extruders (single-worm, double-worm, dry extruders, cooking extruders with/without preconditioning).

[0015] The invention will make it possible to use raw materials in the extrusion process which have hitherto been avoided because of control problems related with the raw materials.

[0016] This situation results in smaller needs for (dependence on) scanty resources/expensive ingredients, and the possibility to a greater extent of composing recipes (raw material compositions) on the basis of nutritional/cost evaluation, with less regard being paid to the performance of the recipe/raw materials from the point of view of extrusion.

[0017] In accordance with the invention, the method will make it possible to increase the capacity of extruders which are mounted with such equipment, since the practical exploitable capacity of many plants is today restricted by the limit of controllability of the product's physical shape.

[0018] The invention, which concerns both a method and a complete plant and an aggregate for building into existing extruders, is illustrated in the drawing, which is a schematic view of an example embodiment of the invention.

[0019] To the left is shown an extruder 2 with a supply funnel or conduit 4 for the material which is to be formed into the desired granular product, and with an extruder worm 6 for transporting the material forward towards a nozzle unit 8 with nozzle channels 10 through which the material is pressed out in string form. In quite the same way as a meat mincer, in front of the nozzle unit 8 there is provided a rotating knife 12 which is driven by a motor 14, the result being that said strings are continuously cut over in the formation of pellets which can simply fall down into a suitable collection or transport arrangement.

[0020] In accordance with the invention, opposite the delivery end of the nozzle unit 8 there is a box element 16 which is connected with the edge of the nozzle unit in a tight-fitting manner, and which also has a tight-fitting sleeve 18 for the drive shaft of the motor 14. The box element 16 has a bottom part in the form of a rotating sluice wheel 20 with sluice pockets 22, in that also here there is hereby a tight-closing sealing of the box element, which from here extends downwards as a discharge chute 24 for the material, which by rotation of the sluice pockets 22 is made to leave the box part 16.

[0021] The box part 16 constitutes a pressure chamber in which, as a consequence of the emission of steam from the material which leaves the nozzle unit 8, there is already built up a certain over-pressure, which can be controlled by venting through a pressure regulation valve 28 and possibly monitored via a pressure transducer 30. Separate pressure supply can take place via

a valve 31 for compressed air or steam, e.g. in a starting phase. Possible condensate will be absorbed by the pellet product, from which it is removed by normal subsequent drying of the product. The escape steam from valve 28 can be utilized for various heating purposes.

[0022] The increased pressure shall serve only or predominantly the purpose of raising the boiling point of the product's water content during the phase in which it leaves the nozzle unit 8, and with precisely this object in mind it will normally be realistic and adequate to operate within a pressure interval of approx. ½-6 bar.

[0023] Down under the sluice wheel - or in principle even above it - there can be disposed a sample-taker 32 which enables a continuous control of the product to be effected, including with regard to its specific weight as a function of its degree of expansion. It has naturally also been possible with the known technique to be able to effect a corresponding supervision with related possibility for adjustment of certain process parameters in front of the nozzle unit 8, but with the invention it is possible to work with a further and extremely important parameter, i.e. the pressure in the chamber 16. Precisely this parameter will be able to be controlled with a minimum of time difference between an ascertained regulation requirement and the execution of the related regulation.

[0024] It will be obvious that the invention will not be limited to the embodiment shown, in that e.g. use can be made of a relatively large pressure chamber 16 in which a batch of discharge material can be accumulated, which can then be removed without the use of any special form of discharge sluice, but possibly during brief stopping of the extruder 2,6.

[0025] The method according to the invention can be based on work for a given process being carried out with associated, manual adjustment parameters, also including for the pressure in the chamber 16, but the work can naturally also be carried out with various degrees of automatic control determined by a given choice of product. It will be appreciated that in such a control system a detected change of pressure or temperature in the pressure chamber will amount to a very fast acting control parameter.

[0026] It should be mentioned that means can be provided inside the chamber 16 to prevent the descending pellets from packing together at the bottom, i.e. so that they are given better time to stabilise in the free state after their formation, e.g. by sliding down in thin layers along a system of inclined plates.

[0027] It has been found that normally it will be fully sufficient if the pressure chamber is designed to operate at a maximum pressure of 6 bar, i.e. it will seldom be advisable to construct it to resist still higher pressures. It will be understood, however, that the invention, in principle, is not directly limited to any particular maximum pressure.

[0028] Until a high experience has been reached it will be advisable to arrange for test runs in order to deter-

mine a desirable operational pressure in the pressure chamber for each new product, just as it is usual to determine the other relevant parameters in this manner for aiming at specific properties of the products.

[0029] As an example, it was desired to determine the sinking capacity of fish feed pellets based on a certain 22% wheat formula extruded through 3.15 mm holes in the die plate. A low number of pellets under different counterpressures were produced and some 25 pellets of each group were measured, bulk weighed and tested for floating characteristics. The following results were noted:

Pressure, bar	0	0.3	1.75
Pellet width average	48 mm	43	42
Std. deviation	2.5	1.4	0.9
Pellet length average	43	45	45
Std. deviation	1.6	1.8	3.3
Bulk weight	526 g/l	626	665
Float:			
4% salt	100%	14%	0%
10% salt	98%	40%	2.5%

Claims

- Extrusion plant, especially for the manufacture of such products which by the associated process heat expand by internal boiling of water by pressure relief after the passage of the product through the extrusion nozzles (10), e. g. foodstuffs or feeding stuffs, in that the plant comprises a nozzle unit (8) and means (2,6) for pressing the product material out through the nozzles (10), **characterized in that** on the discharge side of the nozzle unit (8) there is a pressure chamber (16) connected to temporarily receive the products directly from the nozzle unit (8), said pressure chamber (16) being connected with pressure regulation means (28,31) for maintaining a desired, adjustable pressure in this chamber (16).
- Plant according to claim 1, **characterized in that** the pressure regulation means (28,31) primarily comprise a controlled escape valve (28) for the moderation of the build-up of pressure which is already brought about by the emission of steam from the extruded product.
- Plant according to claim 2, **characterized in that** the pressure regulation means (28,31) further comprise a pressure-controlling valve (31) for the supply of compressed air to the pressure chamber (16).
- Plant according to claim 1, **characterized in that** the pressure regulation means (28,31) are arranged to maintain an overpressure of $\frac{1}{2}$ -6 bar in the pressure chamber (16).
- Plant according to claim 1, **characterized in that** the pressure chamber (16) is arranged for continuous operation, **in that** it is provided with a sluicing-out arrangement (20,22) for continuous discharge of the extruded products.
- Plant according to claim 1, **characterized in that** the pressure chamber (16) is arranged for intermittent operation, i. e. for successive discharge of a large, accumulated portion of extruded products by simple opening out to the atmosphere.
- Unit for building-in to an extrusion plant, **characterized in that** it comprises a chamber part (16) for mounting in a closely-fitting manner on the discharge side of the nozzle equipment (8) of an extruder, thereby providing a plant according to claim 1, said chamber part (16) comprising an escape valve (28) for steam and means (20, 22) for outletting products therefrom.
- A method of extruding such products which by the associated process heat expand by internal boiling of water by pressure relief after the passage of the product through the extrusion nozzles (10), **characterized in** effecting the extrusion into a pressure chamber (16) and maintaining therein a controlled pressure for effectively controlling the temperature of said internal boiling, said pressure preferably being an overpressure of $\frac{1}{2}$ -6 bar.
- A method according to claim 8, whereby an overpressure in the pressure chamber (16) is controlled primarily by a controlled outlet of steam originating from the extruded products.
- A method according to claim 8, whereby the extrusion is effected continuously and the products are currently discharged by means of a sluicing-out arrangement (20,22) or, alternatively, the extrusion is effected discontinuously and the products are discharged batchwise from the pressure chamber (16).

Patentansprüche

- Extrusionsanlage, insbesondere für die Herstellung derartiger Produkte, welche durch das zugehörige Verfahren durch inneres Sieden von Wasser durch Druckablassen nach dem Passieren des Produkts durch die Extrusionsdüsen (10) wärmeexpandieren, beispielsweise Nahrungsmittel oder Futtermittel-

tel, wobei die Anlage eine Düseneinheit (8) und eine Einrichtung (2, 6) zum Pressen des Produktmaterials durch die Düsen (10) aufweist, **dadurch gekennzeichnet, dass** auf der Ausstoßseite der Düseneinheit (8) eine Druckkammer (16) ist, die verbunden ist, um die Produkte von der Düseneinheit (8) temporär direkt zu empfangen, wobei die Druckkammer (16) mit einer Drucksteuereinrichtung (28, 31) zum Aufrechterhalten eines gewünschten einstellbaren Drucks in dieser Kammer (16) verbunden ist.

2. Anlage nach Anspruch 2, **dadurch gekennzeichnet, dass** die Drucksteuereinrichtung (28, 31) primär ein gesteuertes Ablassventil (28) für das Dämpfen des Aufbaus von Druck aufweist, der bereits durch den Ausstoß von Dampf von dem extrudierten Produkt hervorgebracht ist.

3. Anlage nach Anspruch 2, **dadurch gekennzeichnet, dass** die Drucksteuereinrichtung (28, 31) ferner ein Drucksteuerventil (31) für die Zufuhr von Druckluft zu der Druckkammer (16) aufweist.

4. Anlage nach Anspruch 1, **dadurch gekennzeichnet, dass** die Drucksteuereinrichtung (28, 31) angeordnet ist, um einen Überdruck von 0,5-6 Bar in der Druckkammer (16) aufrechtzuerhalten.

5. Anlage nach Anspruch 1, **dadurch gekennzeichnet, dass** die Druckkammer (16) für kontinuierlichen Betrieb angeordnet ist, indem sie mit einer Ausspülanordnung (20, 22) für einen kontinuierlichen Ausstoß extrudierter Produkte ausgestattet ist.

6. Anlage nach Anspruch 1, **dadurch gekennzeichnet, dass** die Druckkammer (16) für periodischen Betrieb angeordnet ist, d.h. für ein sukzessives Ausstoßen eines großen, angesammelten Abschnitts extrudierter Produkte durch einfaches Öffnen zu der Atmosphäre.

7. Einheit zum Einbauen in einer Extrusionsanlage, **dadurch gekennzeichnet, dass** sie einen Kammerteil (16) zum Montieren in eng eingesetzter Weise auf der Ausstoßseite der Düsenausrüstung (8) eines Extruders aufweist, wodurch eine Anlage nach Anspruch 1 bereitgestellt wird, wobei der Kammerteil (16) ein Ablassventil (28) für Dampf und eine Einrichtung (20, 22) zum Auslassen von Produkten von dort aufweist.

8. Verfahren zum Extrudieren derartiger Produkte, welche durch das zugehörige Verfahren durch inneres Sieden von Wasser durch Druckablassen nach dem Passieren des Produkts durch die Extrusionsdüsen (10) wärmeexpandieren, **gekenn-**

zeichnet durch das Bewirken der Extrusion in eine Druckkammer (16) und das Aufrechterhalten eines gesteuerten Drucks darin zum wirksamen Steuern der Temperatur des inneren Siedens, wobei der Druck bevorzugt ein Überdruck von 0,5-6 Bar ist.

9. Verfahren nach Anspruch 8, bei dem ein Überdruck in der Druckkammer (16) primär durch einen gesteuerten Auslass von Dampf gesteuert wird, der von den extrudierten Produkten austritt.

10. Verfahren nach Anspruch 8, bei dem die Extrusion kontinuierlich bewirkt wird und die Produkte laufend mittels einer Ausspülanordnung (20, 22) ausgestoßen werden, oder alternativ die Extrusion diskontinuierlich bewirkt wird und die Produkte stapelweise von der Druckkammer (16) ausgestoßen werden.

Revendications

1. Installation d'extrusion, notamment pour la fabrication de produits qui par le procédé associé s'épanchent sous l'action de la chaleur du fait de l'ébullition interne de l'eau lors de la chute de pression après le passage du produit dans les tuyères d'extrusion (10), par exemple des aliments ou des aliments pour bétail, laquelle installation comprend une unité d'extrusion (8) et des moyens pour exercer une pression d'extrusion des produits traités, à travers les tuyères (10) **caractérisée en ce que** du côté décharge de l'unité d'extrusion (8) est disposée une chambre de pression (16) connectée de façon à recevoir temporairement les produits directement de l'unité d'extrusion (8), ladite chambre de pression (16) étant reliée à des moyens de régulation de la pression (28, 31) pour maintenir une pression ajustable souhaitée dans cette chambre.

2. Installation selon la revendication 1, **caractérisée en ce que** les moyens de régulation de la pression (28, 31) comprennent principalement une valve d'échappement (28) commandée, destinée à réduire l'accumulation de pression qui résulte déjà de l'émission de vapeur provenant du produit extrudé.

3. Installation selon la revendication 2, **caractérisée en ce que** les moyens de régulation de la pression (28, 31) comprennent en outre une valve réglage de pression (31) pour l'alimentation d'air comprimé à la chambre de pression (16).

4. Installation selon la revendication 1, **caractérisée en ce que** les moyens de régulation de la pression (28, 31) sont réglés pour maintenir une surpression de 0,5 à 6 bars dans la chambre de pression (16).

5. Installation selon la revendication 1, **caractérisée**

en ce que la chambre de pression (16) est réalisée pour fonctionner en continu et **en ce qu'elle** comporte un dispositif de chasse (20, 22) pour la décharge en continu des produits extrudés.

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6. Installation selon la revendication 1, **caractérisée en ce que** la chambre de pression (16) est réalisée pour fonctionner en discontinu, c'est-à-dire pour la décharge successive d'une proportion accumulée importante de produits extrudés par simple mise à l'atmosphère. 10
7. Unité pour logement dans une installation d'extrusion **caractérisée en ce qu'elle** comprend une partie formant chambre (16) destinée à être montée d'une façon étroitement ajustée au côté de décharge de l'unité d'extrusion (8) d'une extrudeuse, de façon à former une installation selon la revendication 1, ladite partie formant chambre (16) comprenant une valve d'échappement (28) de vapeur et des moyens (20, 22) pour en permettre la sortie des produits. 15 20
8. Un procédé d'extrusion de produits qui, par le procédé associé s'épandent sous l'action de la chaleur du fait de l'ébullition interne de l'eau lors de la chute de pression après le passage du produit dans les tuyères d'extrusion (10), **caractérisée en ce que** l'extrusion est réalisée dans une chambre de pression (16) et **en ce que** l'on maintient une pression contrôlée pour commander de façon efficace la température de ladite ébullition interne, ladite pression étant de préférence une surpression de 0,5 à 6 bars. 25 30
9. Un procédé selon la revendication 8, dans lequel une surpression produite dans la chambre de pression (16) est principalement contrôlée par une sortie contrôlée de vapeur produite par les produits extrudés. 35 40
10. Un procédé selon la revendication 8, dans lequel l'extrusion est effectuée en continu et les produits sont constamment déchargés par un dispositif de chasse (20, 22) ou, selon une variante, l'extrusion est effectuée en discontinu et les produits sont déchargés par lots de la chambre de pression (16). 45

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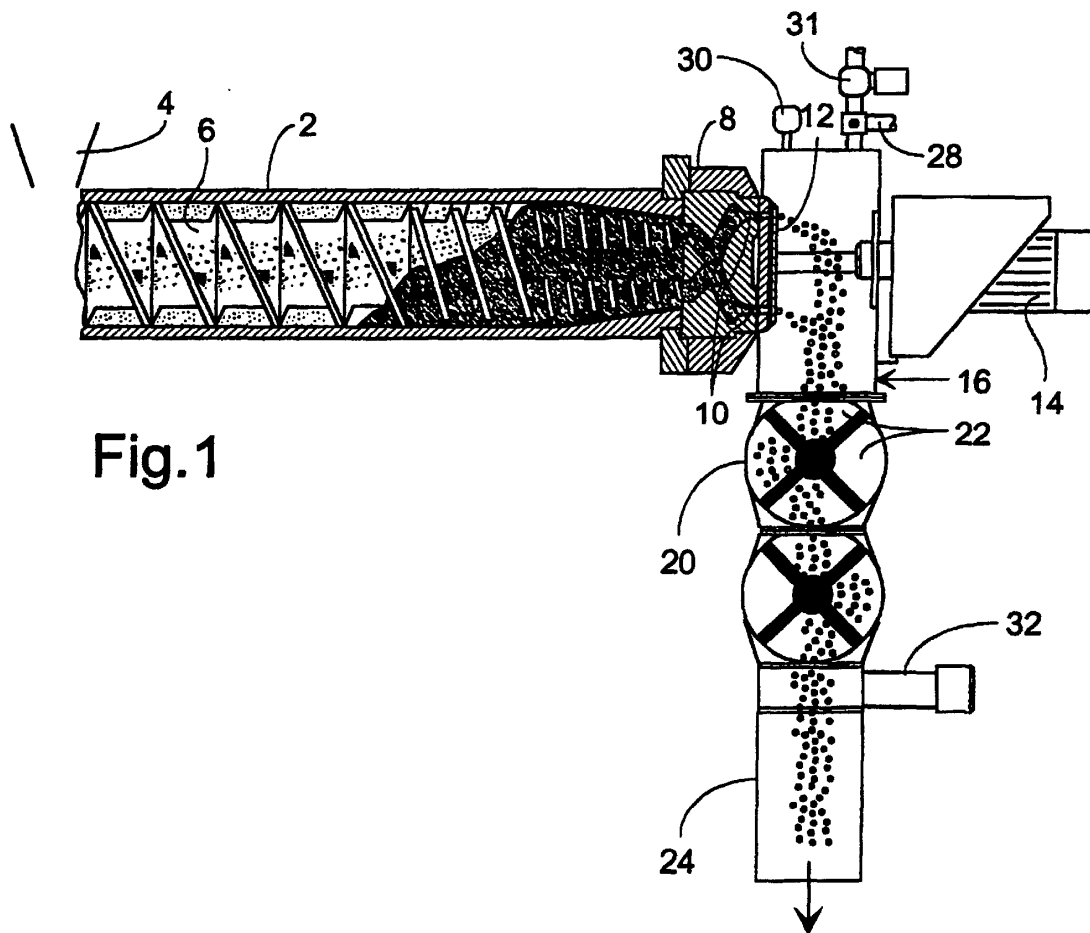


Fig. 1